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This morning I will briefly indicate the importance of gas in relation to other forms of energy in the Soviet economy during the 1980s, examine the "hardware" factors affecting attainment of production increases, and, finally, consider the outlook for 1985 and implications for the domestic economy of the Soviet Union.

Soviet Gas in the 1980s

For the energy sector of the Soviet economy the 1980s are indeed the decade of natural gas. As illustrated in Figure 1, oil production now is flat and coal production has been sagging. (Discuss table.) The managerial and technical advances needed to efficiently exploit Siberia's huge reserves of low-grade coal lie many years in the future, and nuclear power will become a major energy source in the USSR only beyond 1990. In this decade, growth in energy production to fuel the expansion of domestic industry and to bolster hard currency earnings must come from expanded production and transport of natural gas. In examining factors bearing on Soviet ability to expand production of natural gas, we find that the first factor, reserves, is not a problem.

With explored reserves probably topping 30 trillion M^3--or roughly one-third of proved world reserves--and augmentation of production by new drilling much less a problem than in the case of oil, the main constraints on expansion of Soviet gas production lie elsewhere--in gas processing plants and pipeline capacity.

Roughly 25 trillion M^3 of Soviet gas reserves are located in West Siberia's northern Tyumen' area, close to the Arctic Circle. The gas there is very clean, but that in the Orenburg field (2 trillion M^3 of gas) and in the Central Asian fields (3 trillion M^3) is highly corrosive, with heavy concentrations of hydrogen sulfide and carbon dioxide. For production of these corrosive gases, high-pressure non-corrosive well-completion equipment, pipe and valves, and gas processing facilities are essential.

At West Siberia's Urengoy deposit, which must account for the bulk of increased output in the current plan period, Soviet plans call for the commissioning of an additional 13 to 15 gas processing plants by the end of 1985. These units are manufactured in the USSR, but rely heavily on cryogenic equipment from the West. Construction of gas processing plants has been slow, however, and may account for some of the recent shortfall from planned production at Urengoy.

With the major sources of gas in northern Tyumen' (as well as those in Central Asia) located some 2,500 to 3,000 km from domestic industrial centers and roughly 4500 km from the export terminal at Uzhgorod near the border with Czechoslovakia, pipeline capacity will obviously be a major determinant of success or failure in achieving planned increases in gas output. To cope with the challenge of moving huge quantities of gas now being produced, the Soviets have already built over 130,000 km of gas trunklines--some 65,000 km during the past decade.

Historical Vignette

The Soviet natural gas trunkline system has progressively expanded in diameter as well as in length of pipe. Many of the early lines were 720mm diameter. The first 1020mm line was completed in 1962; 1220mm pipe was first used in 1967. Since laying their first 1420mm gas pipe in 1972, between Ukhta and Torzhok on the Northern Lights route, the Soviets have accumulated a decade of experience in handling this large pipe. By the end of 1980, some 17,000 km of 1420mm pipeline had been constructed. Those 1,420mm lines, together with the domestic lines and the export pipeline planned for completion in the current FYP period are shown on the maps that accompany Figures 2 and 3. Not shown is some 115,000 km of smaller trunklines and laterals in the Soviet gas pipeline grid. (Discuss maps and discrepancies in Soviet publications briefly.)

All of the 1420mm pipe has been imported. The Soviets have not succeeded in mass producing large-diameter pipe of high quality and strength for gasline service at 75 atmospheres. Much of the Soviet pipeline system operates at lower pressures and, consequently, the throughput is below that theoretically attainable for the size of pipe used. It has been common for pipelines to operate with only a part of designed compressor capacity installed. Such conditions entail added costs per unit of gas delivered that might not be acceptable in Western market economies. But the Soviets are inured to such second-best solutions and--despite likely difficulty in marshalling equipment and manpower--plan to increase pipeline gas deliveries by almost half from 1980 to 1985.

While most of the new large-diameter lines would depend on domestically produced equipment of less than optimum reliability and efficiency, the export line was to have been built with a first-rate array of Western equipment. The added reliability of the system would redound to the advantage of the Western purchasers of Soviet gas, and the supply of equipment financed by Western credits would reduce the investment burden on the Soviet economy. Turning to some specifics of Soviet plans for 1985, we see in Figure 4 some very ambitious goals. Trunkline length, up 48,000 km; compressor power, up 25,400 MW.

By 1985, Moscow expects the huge Urengoy field alone to be producing over 250 billion M^3 of gas annually and total West Siberian output of gas is planned to increase from 156 billion M^3 in 1980 to about 350 billion M^3 in 1985.

To move the huge volumes of gas, six 1420mm (56 inch) pipelines from the Urengoy area are scheduled for the current FYP period. In addition, one of the large lines started during the tenth FYP--from Urengoy to Gryazovets along the "Northern Lights" route--was completed in February 1981. The six 1420mm lines planned include five for supplying gas to the Soviet economy and the first strand of the planned export pipeline for transmission of gas to Western Europe. These are the lines that we saw earlier in Figure 3.

Hardware and Construction Requirements

The pipe and equipment requirements for the planned construction are immense: 48,000 km of pipe and equipment for some 370 compressor stations, including 25,400 MW of compressor power. If we limit our consideration to the six planned 1420mm lines, the amounts are still immense: 20,000km of pipe weighing roughly 13 million tons, about 180 compressor stations with some 14,000 MW of compressor power. We believe, however, that the outlook for aquisition of 1420mm pipe and large pipelayers from Western suppliers may hold completions to about 17,000km instead of the 20,000km planned.

Once pipe is laid and usual delays in construction of compressor station buildings have been overcome, compressor availability becomes the paramount question. In the past, roughly one-third of gas pipeline compressor power was supplied by imported turbines, both industrial-type and aero-derivative. From their experience over the past decade, gas ministry officials have developed a strong preference for the Western heavy duty industrial turbines.

At this point we may observe that the two thirds of pipeline turbine power supplied by units of domestic manufacture have been pushing through Soviet pipelines hundreds of billions of cubic meters of gas annually, despite a record of poor service life and high-cost maintenance. Two of the workhorses of the Soviet gas pipeline system are the 6.3 MW aero-derivative unit produced by the Sumy plant and the 10 MW industrial-type turbine built by the Nevskiy Plant in Leningrad. Data from Soviet technical journals

suggest that about 100 units per year of each of these models is being produced.

Soviet planners undoubtedly have been counting on serial production of a long-awaited 25 MW industrial turbine, under test since 1979 by the Nevskiy Plant. That the outlook for this unit is not the brightest is suggested by reports that the Soviets have approached West European firms to build a 25 MW unit--not of the Nevskiy design but another "Soviet" design believed to be reverse engineering of a popular Western unit embodying US technology. Other turbines of 12 MW and 16 MW capacity are also mentioned as undergoing modification for pipeline service, but we do not see evidence of serial production.

In the current plan period, the Soviets appear to be relying even more heavily on domestically produced turbines to boost compressor power from the 17,600 MW on line in 1980 to the planned 43,000 MW in 1985 (see Figure 4). We are not aware of Soviet turbine orders in the West beyond the 3,050 MW for the export pipeline. Even if they had planned to order another 2,000 MW of turbine power from the West for the large lines, they would still need another 20,000 MW to meet the plan target.

These requirements exceed by a wide margin Soviet production of the 6.3 MW and 10 MW units. Evidently the Soviet planners have been counting heavily on serial production of their own 25 MW turbine by the later years of the plan period. The planned addition of at least 20,000 MW of domestically produced compressor power during the plan period calls for both capacity and dynamism in the Ministry of Power Machinebuilding that have

not been evident in the past. We doubt whether their R&D facilities, production facilities, and management are up to the task.

Other factors will also make even an approach to scheduled completions very difficult for the Soviets. Transportation and other infrastructural problems, shortage of trained manpower, and poor equipment maintenance practices will severely tax the abilities of pipeline builders--especially in the difficult terrain near the Arctic Circle, where cold and permafrost compound construction problems. Despite their experience in laying several thousand kilometers of 1420mm pipe in northern areas, the Soviets still have not achieved a record of reliability for lines laid in permafrost. But despite the difficulties encountered, they continue to build new lines from northern Tyumen'.

We believe for the several reasons discussed that the full plan for five domestic 1420mm trunklines plus the export line will not be fully met by the end of 1985. We believe, for example, that--even if all of the ordered Western equipment were available for the export pipeline--delays in construction of compressor stations in the more remote parts of the pipeline's path would prevent full powering of the line before 1986. While this would hold throughput below the designed capacity, substantial amounts of gas could be moved through the line before the full complement of compressors became available. Indeed, delays of compressor-station completion and of compressor availability well beyond the completion of pipelaying have

occurred frequently in the history of gas pipeline construction. Some relationships between pressure and throughput and compressor-drive power and throughput bearing on the impact of such delays are illustrated in the tabulations in Figure 5. (Discuss tables.)

Before the embargo, after considering 1420 mm pipe availability, likely gas processing plant completion, and other factors, our best estimate of Soviet gas production in 1985 was 585 billion M^3. This would have represented a 6.1 percent average annual gain from 1980--less than the planned 7.7 percent, but still very substantial.

What now? Frankly, the effect of Western sanctions on Soviet gas production--and beyond that on the Soviet economy--is hard to pin down. We cannot exclude the possibility that Moscow might resolve to meet its export commitments to Western Europe by measures such as:

-- Transferring surplus turbines and compressors to the planned export line from existing lines where they are underutilized,

-- switching to the export line materials, labor, and domestically-produced turbines now earmarked for domestic lines, and

-- adding about 1,300 km of 1,420 mm pipeline to link Novopskov or Yelets (which together will have four 1,420 mm "domestic" lines bringing gas from Urengoy) to Uzhgorod, thus making possible a link up with Western Europe by 1984-85.

By using such measures, we think the Soviet Union could meet its export obligations, but the domestic cost would be substantial. Depending on the specific options used, completion dates for reaching full capacity on one, or possibly two, of the planned domestic trunklines would have to be postponed. If, as we believe, the Soviets do not produce nearly as much turbine capacity for their domestic gas lines as they apparently are planning, an all-out effort to meet gas export commitments could delay for several years gas deliveries ranging up to about 30 billion cubic meters per year.

With the loss of the export pipeline or with diversion of a "domestic" line to serve the export market, gas production in 1985 might be reduced to about 555 billion M^3. According to our reading of the gas balance, domestic gas consumption would then rise by only 5.5 percent per year in 1981-85, compared with the 8.6 percent per year implied in the Soviet plan for 1985. Whether such a shortfall would be a hard or glancing blow to the economy depends on a number of factors. Our forecasts of Soviet oil and coal production are more pessimistic than most; this leads to assessment of failure to meet gas production plans as being relatively more serious. On the other hand, we consider Soviet plans regarding substitution of gas for oil to be overly ambitious and think that Soviet economic growth will be substantially less than planned. Under these circumstances, domestic requirements for gas in the mid-1980s will be less than Moscow calculated when it put together the 1981-85 Plan. There is no way to predict the outcome; but we believe that a course of

action resulting in the loss of 30 billion cubic meters of gas, coupled with the anticipated near stagnation in the combined energy availability from oil and coal, would impose a considerable strain on the domestic energy balance.